XXX. SOME USES OF ARTIFICIAL DAYLIGHT IN THE PSYCHOLOGICAL LABORATORY

By A. J. Brown

The use of daylight in matching colored objects or surfaces is unsatisfactory, because daylight varies throughout the day and on different days in composition and intensity, thus altering both hues and tints. Artificial light possesses an advantage in that both its intensity and its composition can be controlled. Sources of artificial daylight, which duplicate certain conditions of natural daylight and which thus furnish desirable constant conditions for work with colors, have recently been developed by Luckiesh[1] and by Gage.[2] There is no reason why the psychologist should not avail himself of these sources of illumination.[3]

We have recently compared in the Cornell Laboratory color-matches under ordinary 'laboratory' daylight with matches under illumination by an 8⅜-in. roundel (convex, acid-etched) of Gage's glass used with a 100-watt nitrogen-filled Mazda lamp.[4] The conditions were those of the ordinary undergraduate experiment in color-mixing. Hering B and Y and Milton-Bradley G and R paper were matched to gray (Bk-W). The matches were made in a dark room; the daylight matches with the window-shutters open, the matches under artificial light with the lamp placed above and in front of the mixer. The results, in degrees, for 14 observers (all practised in color-mixing) are as follows:

RED-GREEN TRIALS

NATURAL DAYLIGHT					ARTIFICIAL DAYLIGHT				
Outside			Inside		Outside			Inside	
R	G	Y	Bk	W	R	G	Y	Bk	W
215	145	...	274	86	216.5	153.5	....	287	73
210	150	...	270	90	215	145	....	294	66
207	153	...	263	97	212	148	....	285	75
211	149	...	275	85	206	144	10	280	80
220	140	...	275	85	225	135	....	296	64
222.5	137.5	...	288	72	224.5	135.5	....	295	65
212	148	...	275	85	219	141	....	283	77
207.5	149.5	3	272.5	87.5	215.5	140.5	4	285	75

[1] M. Luckiesh. *Color and Its Applications*, 1915, 224-251, 302-311.

[2] H. P. Gage. "Daylite Glass," Sibley Journal of Engineering, 30, 1916, 247-250.

[3] We are here speaking of the routine-work of the laboratory, and not of such research as requires a special optics-room (see C. E. Ferree and G. Rand, *Psych. Rev.*, xix, 1912, 364ff).

[4] The outfit is described by Gage, *op. cit.* The complete unit (glass, reflector, *etc.*, without lamp) can be bought for about $8; the glass roundel alone for $2.75.

	212	148	...	272	88	210.5	145.5	4	284	76
	218	142	...	274.5	85.5	218.5	141.5	....	290	70
	194	157	9	268	92	200	152	8	278	82
	211.5	144.5	4	271	89	215	141	4	287.5	72.5
	210	145	5	267	93	211	139	10	288.5	71.5
	208	148	4	268	92	212	144	4	278.5	81.5
Av...	211.3	146.9	1.8	272.4	87.6	214.4	142.5	3.1	286.5	73.5
M. V.	4.5	3.9	2.3	3.9	3.9	4.9	3.5	3.1	4.6	4.6

BLUE-YELLOW TRIALS

NATURAL DAYLIGHT					ARTIFICIAL DAYLIGHT			
Outside			Inside		Outside		Inside	
B	Y	R	Bk	W	B	Y	Bk	W
193	167	...	210	150	192.5	167.5	216	144
191	169	...	210	150	187	173	208	152
190	170	...	205	155	185	175	207	153
191	169	...	207	153	191	169	199	161
187	173	...	202	158	186	174	190	170
192	168	...	202	158	189	171	197	163
190.5	169.5	...	205	155	189	171	202.5	157.5
187	173	...	212	148	192	168	202	158
188.5	170.5	1	205	155	190	170	197	163
186.5	173.5	...	212	148	192	168	202	158
191.5	168.5	...	205.5	154.5	190.5	169.5	195.5	164.5
188	172	...	198.5	161.5	187.5	172.5	191	169
192	168	...	206	154	188.5	171.5	204	156
190	170	...	202	158	186	174	190	170
Av.. 189.2	170.8	....	205.9	154.1	189.0	171.0	200.1	159.9
M. V. 1.9	1.9	....	3.1	3.1	2.0	2.0	5.9	5.9

The differences in the average amounts of Bk and W under the two illuminations are probably to be accounted for by the fact that the daylight illumination was more intense than the artificial.[5]

The differences in the average amounts of color are not great. In the R-G trials (this pair of papers is the more difficult to match), the differences are 3.1°R. 4.4°G, and 1.3°Y (some observers required a little yellow). In the Y-B trials, the differences are 0.2°Y and 0.2°B. In the R-G case the differences between the two illuminations are comparable to the M.V. among observers under either illumination; in the Y-B case, the differences are negligible. Certainly no violence in the way of alteration of hues would be done to the undergraduate experiment in color-mixing if it were performed in the dark room under artificial daylight; whereas the very great advantage of constant illumination would be secured. No one who has witnessed the discouragement of the careful student whose color-equations fail to check in the waning light of the afternoon will underestimate the desirability of light of constant intensity for such

[5] Cf. L. R. Geissler, this JOURNAL, xxiv, 1913, 178.

work. Not only the color-mixing but also the contrast experiment, and many of the psychophysical experiments upon brightness, would be facilitated by the use of artificial daylight.

We have also tried out this light as a possible means of color-demonstration for lectures in the evening or in poor daylight. In the usual illumination of the large lecture-room in the Cornell Laboratory in the evening it has not been possible to use the various colored charts and models, painted in oils: the color-pyramid, the color-square, the psychological spectrum, the chromatic scale of blues, and the two typical spectra of color-blindness. The blues fade into light grays, the greens almost disappear in dark grays, and the reds become orange. With artificial daylight the colors are restored. It is not even necessary to turn out the yellowish lights of the room. If the charts are placed directly beneath the source of artificial daylight, the colors are brought out as soon as this light is turned on, and are not noticeably altered by turning off or on the other lights of the room. The effect is, in fact, much pleasanter if the general yellowish illumination of the room is allowed to remain unchanged when the artificial daylight is thrown on the charts; for then the demonstration does not contrast strongly in brightness with its surroundings. For long charts (over 4 feet) two such light-units as we used are necessary. Especially is this true for the chromatic series, where the blues fade readily into grays. Two such units will illuminate the color-pyramid so that it can be seen, in true colors and without shadows, from all parts of the room.

The artificial daylight is equally satisfactory for other color-demonstrations, such as the exhibition of the matches of worsteds made by color-blind persons. We found also that a single light-unit could be used with the Ragona Scina apparatus for the demonstration of color-contrast. When some of the thinner glasses are used in the apparatus, and the light is placed in front and to one side of the apparatus-box, a contrast-effect is produced which is visible at a greater distance than is ordinarily the case in daylight.